Organic Chemistry

Types of alkyl groups:

* $-CH_3$ (Methyl)
* CH_3-CH_2- (or) C_2H_5- (Ethyl)
* $CH_3-CH_2-CH_2-$ (n-propyl)
* $CH_3-\underset{\displaystyle CH_3}{\overset{|}{CH}}-$ (or) $(CH_3)_2CH-$ Iso-propyl
* $CH_3-CH_2-CH_2-CH_2-$ (n-Butyl)
* $CH_3-\underset{\displaystyle CH_3}{\overset{|}{CH}}-CH_2-$ (Iso butyl)
* $CH_3-\underset{\displaystyle CH_3}{\overset{\displaystyle CH_3}{\overset{|}{C}}}-$ (3° butyl)
* $CH_3-\underset{\displaystyle H}{\overset{|}{CH}}-CH_2-CH_3$ (2° Butyl)
* $CH_3-CH_2-CH_2-CH_2-CH_2-$ (n-pentyl) (n-amyl)
* $CH_3-\underset{\displaystyle CH_3}{\overset{|}{CH}}-CH_2-CH_2-$ (Iso pentyl) (Iso amyl)
* $CH_3-\underset{\displaystyle CH_3}{\overset{\displaystyle CH_3}{\overset{|}{C}}}-CH_2-$ (Neo pentyl)
* $CH_3-\underset{\displaystyle H}{\overset{|}{CH}}-CH_2-CH_2-CH_3$ (2° pentyl)

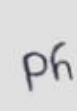
Types of alkenyl groups:

Alkenyl	Common name	IUPAC name
$CH_2=CH-$	Vinyl	Ethenyl
$CH_2=CH-CH_2-$	Allyl	2-Propenyl
$CH_3-CH=CH-$	–	1-Propenyl

Types of alkynyl groups:

Alkynyl	Common name	IUPAC name
$HC\equiv C-$	Acetylide	Ethynyl
$CH_3-C\equiv C-$	Propargyl	Propynyl

$CH_2 = CH - Cl$ (Vinyl chloride)

Ph- | C_6H_5- |  (Phenyl / Aryl)

Ph-Cl | C_6H_5-Cl | (Chloro benzene)

Ph-CH_2- | C_6H_5-CH_2- | (Benzyl)

Ph-CH_2-Cl | C_6H_5-CH_2-Cl | (Benzyl chloride)

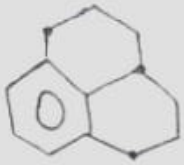
$CH_2 = CH - CH_2 - Cl$ (Allyl chloride)

Eg:

$CH_2 = CH - \underline{CH_3}$ → Allylic hydrogen

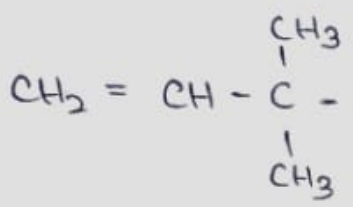
(propene) 3 Allylic hydrogens

(Toulene) 3 Benzylic hydrogen



5 Benzylic hydrogen

$CH_2 = CH - \underline{CH_2} - CH_3$ 2 Allylic hydrogen



No allylic hydrogen (0)

IUPAC nomenclature of functional groups:

i) Alkyl halide:

GF: R-X : $C_nH_{2n+1}-X$ (X = F, Cl, Br, I)

IUPAC : Halo alkane

R-X	Common name / Trivial name	IUPAC name
CH_3Cl	Methyl chloride	Chloromethane
CH_3CH_2Cl	Ethyl chloride	Chloroethane
$CH_3CH_2CH_2Cl$	Propyl chloride	Chloropropane
$CH_3-\underset{\displaystyle Cl}{\underset{\vert}{CH}}-CH_3$ (OR) $(CH_3)_2CH-Cl$	Isopropyl chloride	2-chloro propane
$CH_3CH_2CH_2CH_2Cl$	n-Butyl chloride	Chloro butane
$CH_3-\underset{\displaystyle CH_3}{\underset{\vert}{CH}}-CH_2-Cl$	Iso butyl chloride	1-chloro-2-methyl propone
$CH_3-\underset{\displaystyle CH_3}{\underset{\vert}{C}}-Cl$ $\underset{\displaystyle CH_3}{\vert}$ (OR) $(CH_3)_3CCl$	3° Butyl chloride	2-chloro-2-methyl propane
$CH_3-\underset{\displaystyle Cl}{\underset{\vert}{CH}}-CH_2-CH_3$	2° Butyl chloride	2-chloro butane
$CH_3CH_2CH_2CH_2CH_2Cl$	n-pentyl chloride	chloro pentane
$CH_3-\underset{\displaystyle CH_3}{\underset{\vert}{CH}}-CH_2-CH_2-Cl$	Iso pentyl chloride	1-chloro-3-methyl butone
$CH_3-\underset{\displaystyle CH_3}{\underset{\vert}{C}}-CH_2-Cl$ $\underset{\displaystyle CH_3}{\vert}$	Neo pentyl chloride	1-chloro-2,2-dimethyl Propane

Types of alkyl halides:

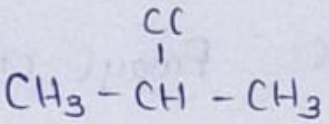
Classified into three types:

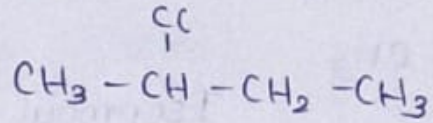
1° R-X ($R-CH_2-X$) ; 2° R-X (R_2CHX) ;

3° R-X (R_3CX)

Eg: $CH_3-[CH_2-Cl]$

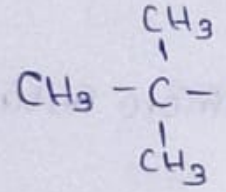
$CH_3-CH_2-[CH_2-Cl]$

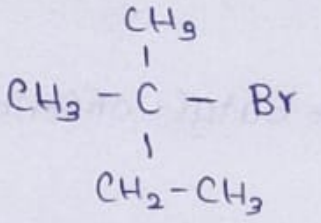




1° R-X

2° R-X



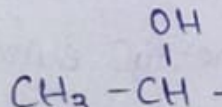


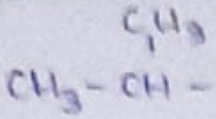
3° R-X

ii) Alcohols:

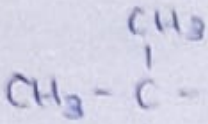
GF: R-OH ($C_nH_{2n+1}-OH$)

IUPAC: Alkanol

R-OH	Common name	IUPAC name
CH_3OH (carbinol)	Methyl alcohol	Methanol
CH_3CH_2OH (methyl carbinol)	Ethyl alcohol	Ethanol
$CH_3CH_2CH_2OH$	Propyl alcohol	Propanol
	Iso propyl alcohol	Propan-2-ol
$CH_3CH_2CH_2CH_2OH$	n-Butyl alcohol	Butanol

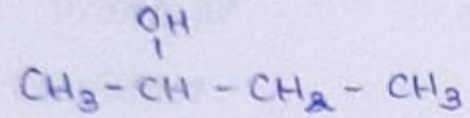


Iso Butyl alcohol — 2-methyl-1-propanol

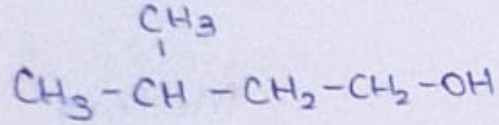


Tertiary butyl alcohol — 2-methyl-2-propanol

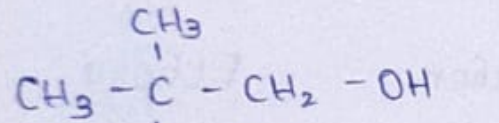
$CH_3CH_2CH_2CH_2CH_2OH$ — Pentyl alcohol — Pentanol



2° Butyl alcohol — 2-Butanol



Iso pentyl alcohol / Iso amyl alcohol — 3-methyl-1-Butanol



(OR) $(CH_3)_3CCH_2OH$

Neo pentyl alcohol — 2,2-dimethyl Propanol

Types of alcohols:

Classified into three types:

1° R-OH $(R-CH_2-OH)$; 2° R-OH (R_2CHOH)

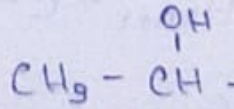
3° R-OH (R_3COH)

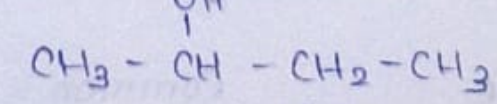
Eg: $R-CH_2-OH$:

CH_3-CH_2-OH

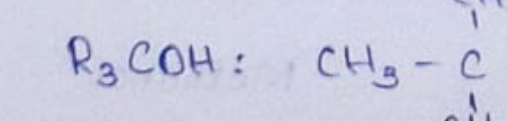
$CH_3-CH_2-CH_2-OH$

R_2CHOH:





R_3COH:



iii) Ethers:

GF: $R-O-R$ $(C_nH_{2n+1}-O-C_nH_{2n+1})$

IUPAC: Alkoxy alkane

R-O-R	Common name / Trivial name	IUPAC name
CH_3-O-CH_3 (Alkoxy has less number of carbons)*	Dimethyl ether	Methoxy methane
$CH_3-CH_2-O-CH_3$ (OR) $CH_3-O-CH_2-CH_3$	Ethyl methyl ether	Methoxy ethane
$CH_3-CH_2-O-CH_2-CH_3$	Diethyl ether	Ethoxy ethane
$CH_3-CH_2-CH_2-O-CH_3$	Propyl methyl ether	Methoxy propane
$CH_3-\overset{2}{C}H(\overset{1}{C}H_3)_2-O-CH_3$ (OR) $(CH_3)_2CH-O-CH_3$	Isopropyl methyl ether	2-methoxy propane

iv) Aldehydes:

GF: $R-CHO$ $(C_nH_{2n+1}-\overset{O}{\overset{\|}{C}}-H)$

IUPAC: Alkanal

Aldehyde	Common name	IUPAC name
$H-\overset{O}{\overset{\|}{C}}-H$	Formaldehyde	Methanal

$CH_3-\overset{\overset{O}{\|}}{C}-H$	Acetaldehyde	Ethanal
$CH_3-CH_2-\overset{\overset{O}{\|}}{C}-H$	Propionaldehyde (or) Propanaldehyde	Propanal
$CH_3-CH_2-CH_2-\overset{\overset{O}{\|}}{C}-H$	Butyraldehyde	Butanal
$CH_3-\overset{CH_3}{\underset{2}{CH}}-\overset{\overset{O}{\|}}{\underset{1}{C}}-H$ (3 2 1)	Iso butyraldehyde	2-methyl propanal

v) Ketones:

GF: $R-\overset{\overset{O}{\|}}{C}-R$ $(C_nH_{2n+1}-\overset{\overset{O}{\|}}{C}-C_nH_{2n+1})$

IUPAC: Alkanone

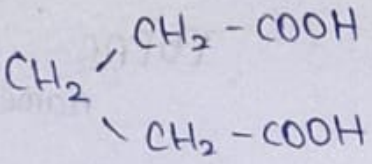
Ketone	Common name	IUPAC name
$CH_3-\overset{\overset{O}{\|}}{C}-CH_3$	Acetone / dimethyl acetone	2-propanone
$CH_3-\overset{\overset{O}{\|}}{C}-CH_2-CH_3$	Methyl ethyl ketone	2-Butanone
$CH_3-CH_2-\overset{\overset{O}{\|}}{C}-CH_2-CH_3$	Diethyl ketone	3-pentanone

vi) Carboxylic acids:

GF: $R-COOH$ $(R-\overset{\overset{O}{\|}}{C}-OH \;/\; C_nH_{2n+1}-\overset{\overset{O}{\|}}{C}-OH)$

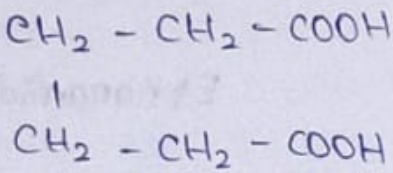
IUPAC: alkanoic acids

RCOOH	Common name	IUPAC name
$HCOOH$	Formic acid	Methanoic acid
CH_3COOH	Acetic acid	Ethanoic acid
CH_3CH_2COOH	Propionic acid	Propanoic acid
$CH_3CH_2CH_2COOH$	Butyric acid	Butanoic acid
$CH_3\underset{2}{\underset{\vert}{C}H}(\overset{1}{CH_3})\text{-}\overset{1}{COOH}$	Iso butyric acid	2-methyl Propanoic acid
$CH_3CH_2CH_2CH_2COOH$	Valeric acid	Pentanoic acid
$CH_3\text{-}\underset{3}{\underset{\vert}{C}H}(\overset{1}{CH_3})\text{-}\underset{2}{CH_2}\text{-}\overset{1}{COOH}$	Iso valeric acid	3-methyl butanoic acid
$CH_3CH_2CH_2CH_2CH_2COOH$	Caproic acid	Hexanoic acid
$CH_3\text{-}\underset{4}{\underset{\vert}{C}H}(\overset{1}{CH_3})\text{-}\underset{3}{CH_2}\text{-}\underset{2}{CH_2}\text{-}\overset{1}{COOH}$	Iso caproic acid	4-methyl pentanoic acid
$\overset{1}{COOH}$ / $\overset{2}{COOH}$ $(H_2C_2O_4)$	Oxalic acid	1,2-Ethane dioic acid
$CH_2(\overset{1}{COOH})(\overset{3}{COOH})$	Malonic acid	Propane-1,3-dioic acid
$\overset{2}{CH_2}(\overset{1}{COOH})$ / $\overset{3}{CH_2}(\overset{4}{COOH})$	Succinic acid	Butane-1,4-dioic acid



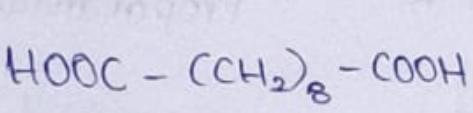
Glutaric acid

Pentane-1,5-dioic acid



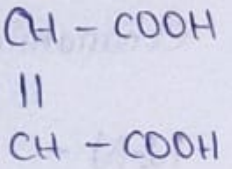
Adipic acid

Hexane-1,6-dioic acid



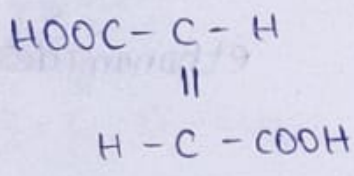
Sebasic acid

Decane-1,10-dioic acid



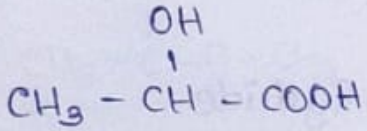
Maleic acid

cis-2-butene-dioic acid

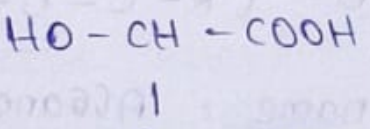


Fumaric acid

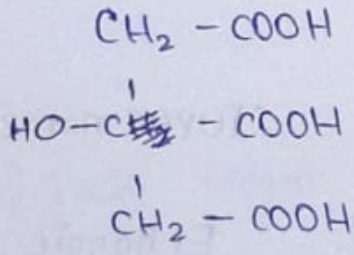
Trans-2-butene dioic acid



(Lactic acid)



(Malic acid)



(citric acid)

vii) Acidamide :

GF : $R-\overset{O}{\overset{\|}{C}}-NH_2$ $(C_nH_{2n+1}-\overset{O}{\overset{\|}{C}}-NH_2)$

IUPAC : Alkanamide

Amide	Common name	IUPAC name
$H-\overset{\overset{O}{\|}}{C}-NH_2$ / $HCONH_2$	Formamide	Methanamide
$CH_3-\overset{\overset{O}{\|}}{C}-NH_2$	Acetamide	Ethanamide
$CH_3CH_2-\overset{\overset{O}{\|}}{C}-NH_2$	Propionamide	Propanamide
$CH_3-\overset{\overset{O}{\|}}{C}-N\begin{matrix}\nearrow CH_3\\ \searrow H\end{matrix}$	N-methyl acetamide	N-methyl ethanamide
$CH_3-\overset{\overset{O}{\|}}{C}-N\begin{matrix}\nearrow CH_3\\ \searrow CH_3\end{matrix}$	N,N-dimethyl acetamide	N,N-dimethyl ethanamides

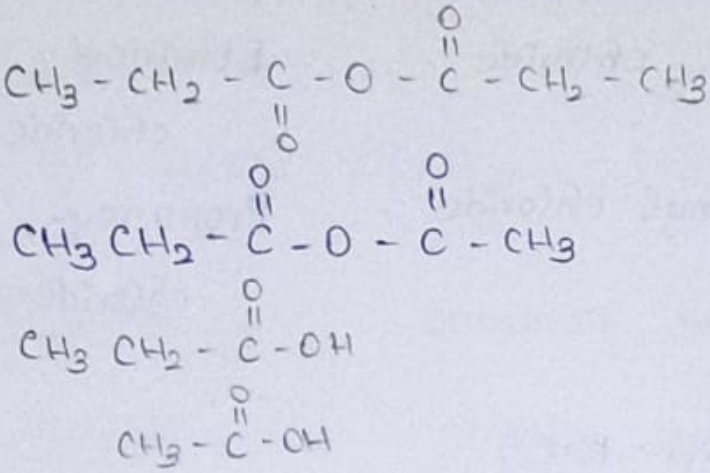
viii) Acid anhydride :

GF : $(RCO)_2O$ $\left(R-\overset{\overset{O}{\|}}{C}-O-\overset{\overset{O}{\|}}{C}-R\right)$

IUPAC name : Alkanoic anhydride

$$C_nH_{2n+1}-\underset{\underset{O}{\|}}{C}-O-\underset{\underset{O}{\|}}{C}-C_nH_{2n+1}$$

Anhydride	Common name	IUPAC name
$(CH_3CO)_2O$	Acetic anhydride	Ethanoic anhydride
$CH_3-\overset{\overset{O}{\|}}{C}-OH$ $CH_3-\underset{\underset{O}{\|}}{C}-OH$	$\left(CH_3-\underset{\underset{O}{\|}}{C}-O-\overset{\overset{O}{\|}}{C}-CH_3\right)$	
$(CH_3CH_2CO)_2O$ $CH_3-CH_2-\overset{\overset{O}{\|}}{C}-OH$ $CH_3-CH_2-\underset{\underset{O}{\|}}{C}-OH$	Propionic acid anhydride	Propanoic anhydride



Propionic anhydride

Propanoic ethanoic anhydride (or) Ethanoic propanoic anhydride

ix) Ester:

GF: $R-\overset{O}{\overset{\|}{C}}-O-R$

$C_nH_{2n+1}-\overset{O}{\overset{\|}{C}}-O-C_nH_{2n+1}$

IUPAC: Alkyl alkanoate

Ester	Common name	IUPAC name
$H-\overset{O}{\overset{\|}{C}}-O-CH_3$	Formic ester	Methyl methanoate
$CH_3-\overset{O}{\overset{\|}{C}}-O-CH_3$	Acetic ester / Dimethyl ester	Methyl ethanoate
$CH_3-\overset{O}{\overset{\|}{C}}-O-CH_2-CH_3$	Methyl ethyl ester	Ethyl ethanoate

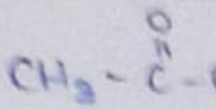
Aceto acetic ester → $CH_3-\overset{O}{\overset{\|}{C}}-CH_2-\overset{O}{\overset{\|}{C}}-O-C_2H_5$

x) Acid halide:

GF: $R-\overset{O}{\overset{\|}{C}}-X$ $(C_nH_{2n+1}-\overset{O}{\overset{\|}{C}}-X)$

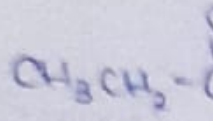
IUPAC: Alkanoyl halide

Acid halide	Common name	IUPAC name
$H-\overset{O}{\overset{\|}{C}}-Cl$	Formyl chloride	Methanoyl chloride



Acetyl chloride

Ethanoyl chloride



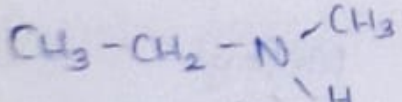
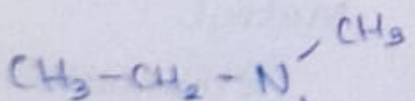
Propionyl chloride

Propanoyl chloride

vi) Amines:

GF: $R-NH_2$ ($C_nH_{2n+1}-NH_2$)

IUPAC: Alkanamine

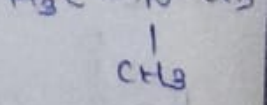
Amine	Common name	IUPAC name
CH_3NH_2 (1°)	Methyl amine	Methanamine
$CH_3CH_2NH_2$ (1°)	Ethyl amine	Ethanamine
 (2°)	N-methyl ethyl amine	N-methyl ethanamine
 (3°)	N,N-dimethyl ethyl amine	N,N-dimethyl ethanamine

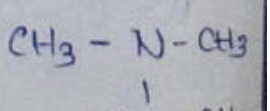
⇒ Amines are classified into three types:

1° Amine (GF: $R-NH_2$) ; 2° Amine (GF: R_2NH)

3° Amine (GF: R_3N)

Eg: CH_3-NH_2 $(CH_3)_2NH$ $(CH_3)_3N$

$CH_3-CH_2-NH_2$ $CH_3-NH-CH_3$ 

$CH_3-NH-CH_2CH_3$ 

xii) Cyanides :

GF : R-CN ($C_nH_{2n+1}-CN$) IUPAC : Alkane nitrile

Cyanide	Common name	IUPAC name
CH_3CN	Methyl cyanide (or) Aceto nitrile	Ethane nitrile
CH_3CH_2CN	Ethyl cyanide	Propane nitrile

xiii) Iso cyanides :

GF : RNC ($R-N^+\equiv C^-$) ($C_nH_{2n+1}NC$) IUPAC : Alkyl carbyl amine

Iso cyanide	Common name	IUPAC name
CH_3NC	Methyl iso cyanide	Methyl carbyl amine
CH_3CH_2NC	Ethyl iso cyanide	Ethyl carbyl amine

*) IUPAC nomenclature of organic compounds having more than one functional group :

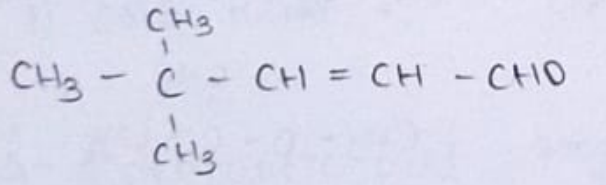
$-COOH$, $-SO_3H$, $-COOR$, $COCl$, $CONH_2$, $-CN$, $-HC=O$, $>C=O$, $-OH$, $-NH_2$, $>C=C<$, $-C\equiv C-$.

Decreasing order of priority

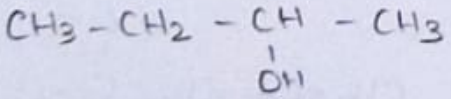
Class of compounds	Functional group structure	IUPAC group prefix	IUPAC group suffix
Alkanes	–	–	-ane
Alkenes	>C=C<	–	-ene
Alkynes	-C≡C-	–	-yne
Arenes	–	–	–
Halides	-X (F, Cl, Br, I)	halo-	–
Alcohols	-OH	hydroxy-	-ol
Aldehydes	-CHO	formyl (or) oxo	-al
Ketones	>C=O	oxo-	-one
Nitriles	-C≡N	cyano	nitrile
Ethers	-R-O-R-	alkoxy-	–
Carboxylic acid	-COOH	carboxy	-oic acid
Carboxylate ions	$-COO^-$	–	-oate

Esters	$-COOR$	alkoxy carbonyl	-oate
Acyl halides	$-COX$ ($X = F, Cl, Br, I$)	halo carbonyl	-oyl halide
Amines	$-NH_2$, $>NH$, $>N-$	amino-	-amine
Amides	$-CONH_2$, $-CONHR$, $-CONR_2$	-carbamoyl	-amide
Nitro compounds	$-NO_2$	nitro	-
Sulphonic acids	$-SO_3H$	sulpho	sulphonic acid

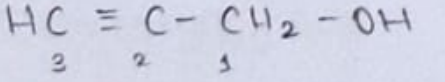
Examples:



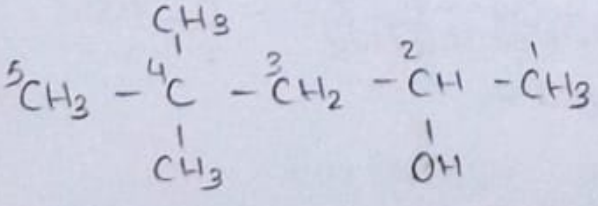
4,4-dimethyl, 2-pentenal



Butan-2-ol

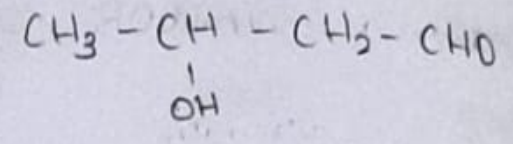


2-propynol



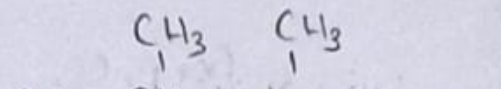
4,4-dimethyl 2-pentanol

3-hydroxy butanal

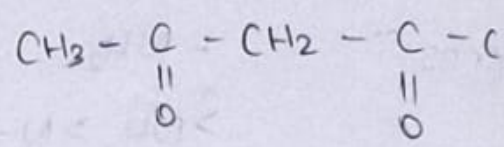


2- butenal

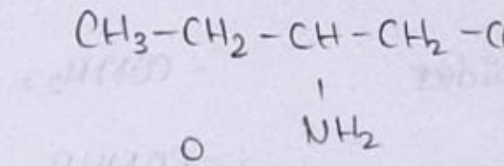
3,4-dimethyl pentane nitrile



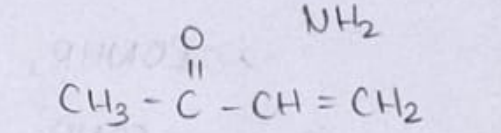
Pent-2,4-dione



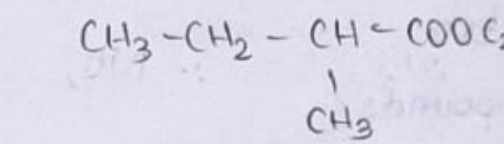
3-amino pentanoic acid



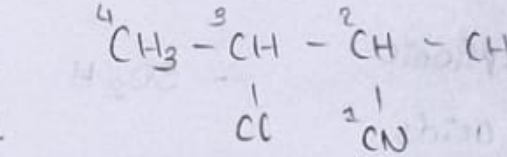
But-3-ene-2-one



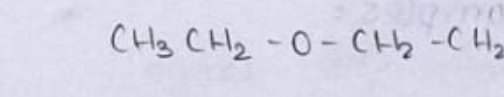
Ethyl, 2-methyl butanoate



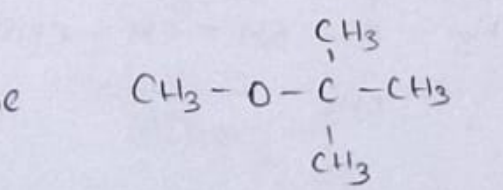
3-chloro 2-methyl butane nitrile



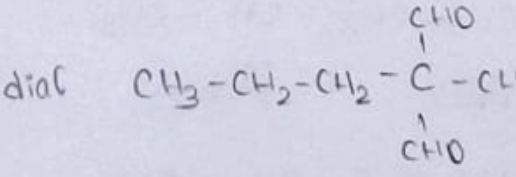
1-chloro ethoxy ethane



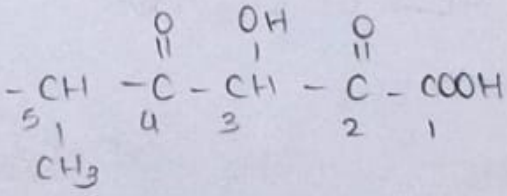
2-methoxy 2-methyl propane



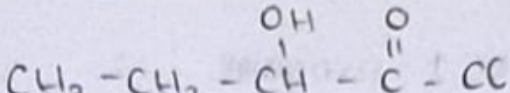
2-ethyl 2-propyl prop-1,3-dial



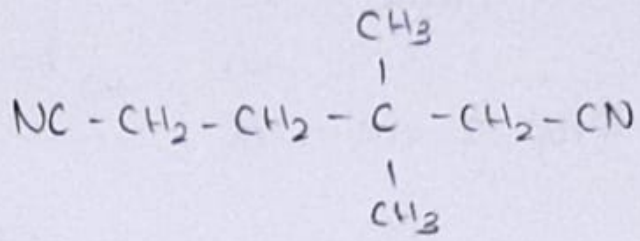
3-hydroxy 5-methyl 2,4-dioxo hex 1,6-dioic acid



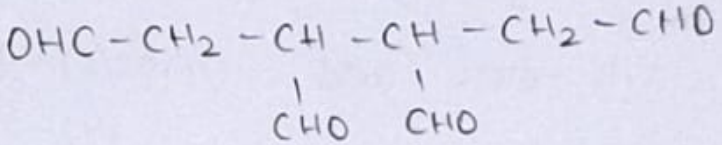
2-hydroxy butanoyl chloride



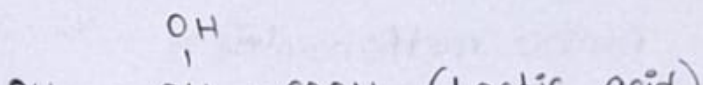
3,3 dimethyl hexane 1,6-di nitrile



3,4-diformyl hexane-1,6-dial

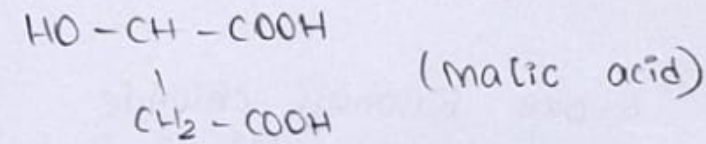


2-hydroxy propanoic acid

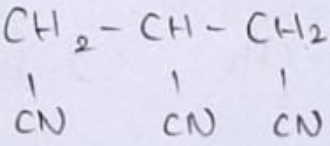


2-hydroxy, 2-phenyl ethanoic acid

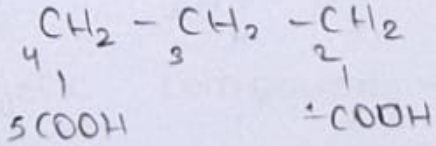
2-hydroxy butan 1,4-dioic acid



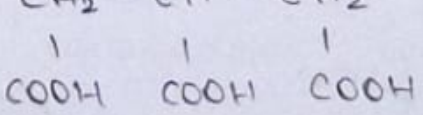
(*) Propane-1,2,3-tri carbo nitrile



1,5-dipentanoic acid



(*) Propane-1,2,3-tri carboxylic acid



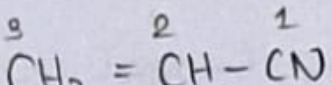
(tricarballylic acid)

(OR)

Carballylic acid

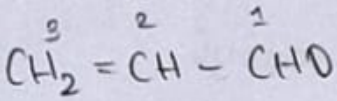
(citric acid)

2- ene, 1- propane nitrile



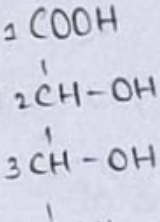
(Acrolein)

Prop-2-ene-1-al



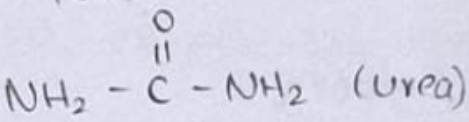
(Acroldehyde)

2,3-dihydroxy butan 1,4-dioic acid



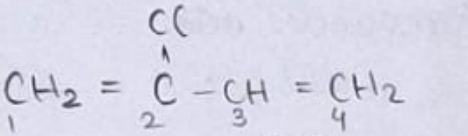
(Tartoric acid)

Amino methanamide



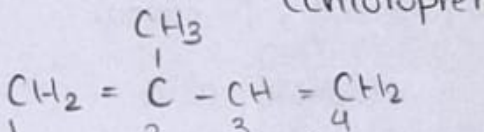
(Urea)

2-chloro, 1,3-butadiene



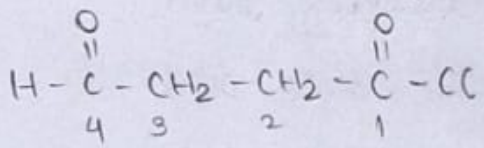
(Chloroprene)

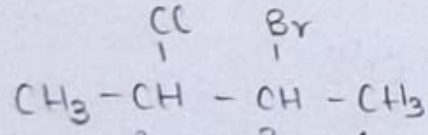
2-methyl, 1,3 butadiene



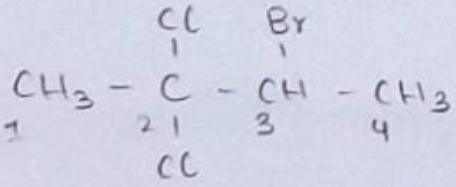
(Isoprene)

4-oxo butanoyl chloride



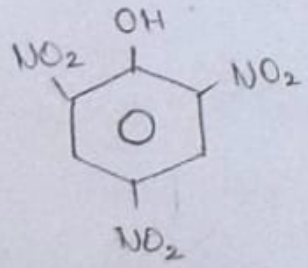


2-Bromo, 3-chloro butane

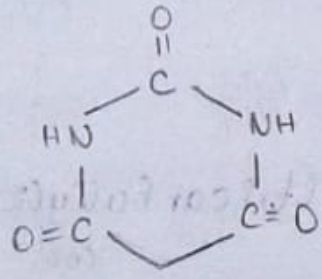


3-Bromo, 2,2-dichloro butane

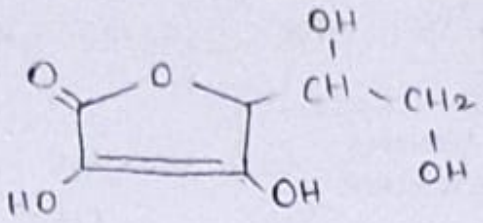
Picric acid



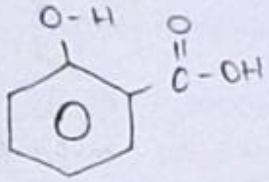
Barbituric acid



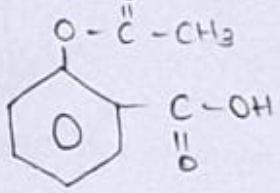
Ascorbic acid



Salicylic acid



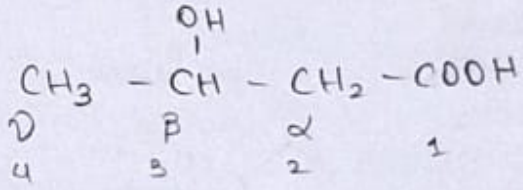
Acetyl salicylic acid (Asprin)



$CH_3 - CH_2 - CH_2 - COOH$

D B α FG

β-hydroxy butanoic acid



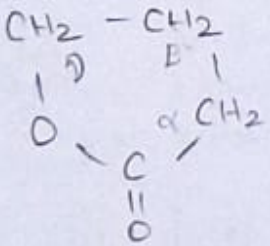
D B α 1

4 3 2

D B α

$CH_2 - CH_2 - CH_2 - COOH$

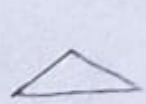
OH $\Delta \downarrow -H_2O$



* R-SH (Thio alcohol)

(Mercapto)

Nomenclature of acyclic compounds:

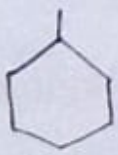


Cyclo propane

Cyclo butane

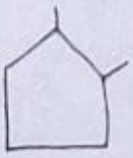
Cyclo pentane

Cyclo hexane

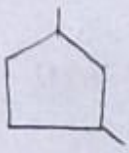


1-methyl cyclo hexane

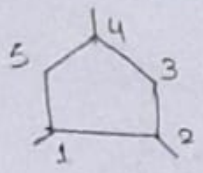
1,1-dimethyl cyclo pentane



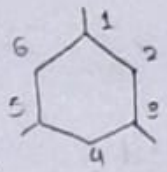
1,2-dimethyl Cyclo pentane



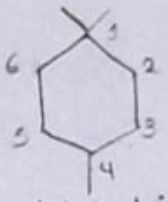
1,3-dimethyl cyclo pentane



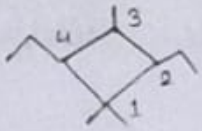
1,2,4- trimethyl cyclo pentane



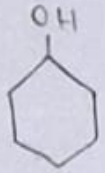
1,3,5 trimethyl cyclo hexane



1,1,4 trimethyl cyclo hexane

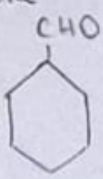


2,4- diethyl 1,1,3- trimethyl cyclo butane

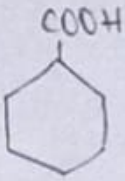


Cyclo hexanol

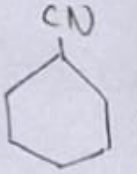
cyclo hexane thiol



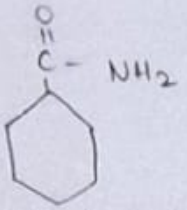
cyclo hexane carbaldehyde



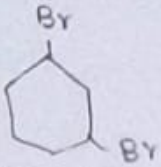
cyclo hexane carboxylic acid



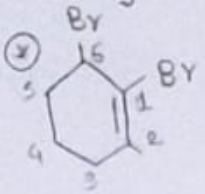
carbo nitrile cyclo hexane



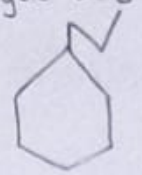
Cyclo hexane carbonamide



1,3 dibromo cyclo hexane

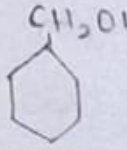


1,6-dibromo cyclo hexene

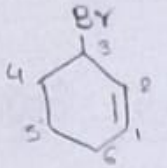


Propyl cyclo hexane

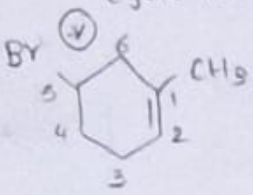
Iso cyano cyclic hexane



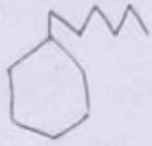
Cyclo hexyl methanol



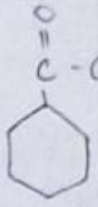
3-Bromo cyclo hexene



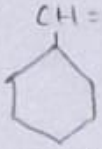
5-Bromo, 1-methyl cyclo hexene



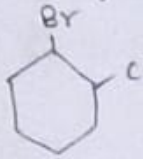
Hexyl cyclo hexane



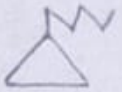
cyclo hexane carbonyl chloride



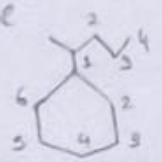
Cyclo hexyl ethene



1-Bromo 2-methyl cyclo hexane

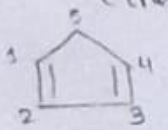


Cyclo propyl pentane

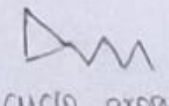


1-(1-methyl butyl) cyclo hexane

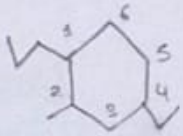
cyclo pentene



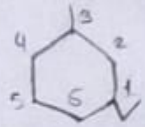
1,3-cyclo penta diene



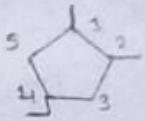
cyclo propyl pentane



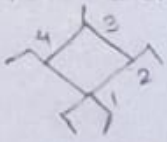
4-ethyl, 2-methyl, 1 propyl cyclo hexane



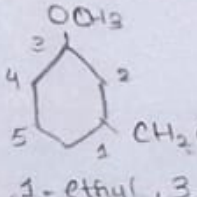
1-ethyl, 3-methyl cyclo hexane



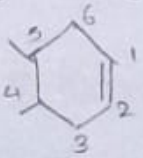
4-ethyl, 1,2-dimethyl cyclo pentane



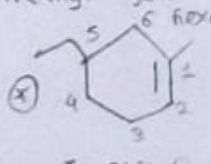
1,1 2,4-tetra ethyl 3-methyl cyclo butane



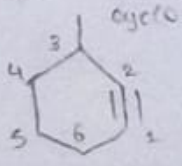
1-ethyl, 3-methoxy cyclo hexane



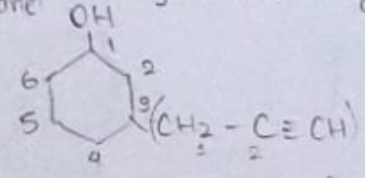
4,5-dimethyl cyclo hexene



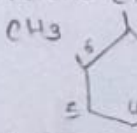
5-ethyl, 1-methyl cyclo hexene



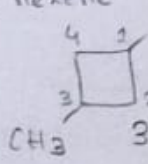
3-methyl cyclo hexyne



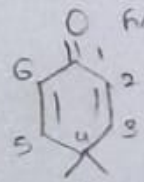
3-(2-propynyl) cyclo hexanol



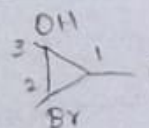
2-Bromo, 6-methyl cyclo hexane carbaldehyde



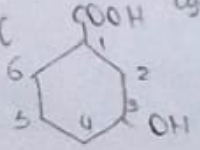
3-methyl cyclo butane carbaldehyde



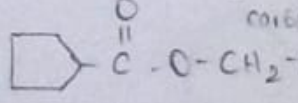
4,4-dimethyl, cyclo hex 2,5-dienone



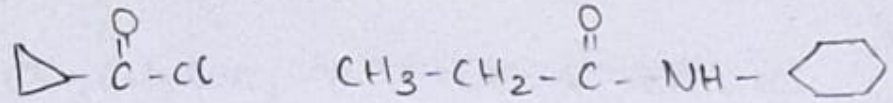
2-Bromo, 3-hydroxy cyclo propane carboxylic acid



3-hydroxy cyclo hexane carboxylic acid

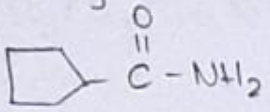


Propyl cyclo pentyl methanoate

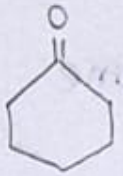


Cyclo propane carbonyl chloride

n-cyclo hexyl propanamide



cyclo pentane carboxamide



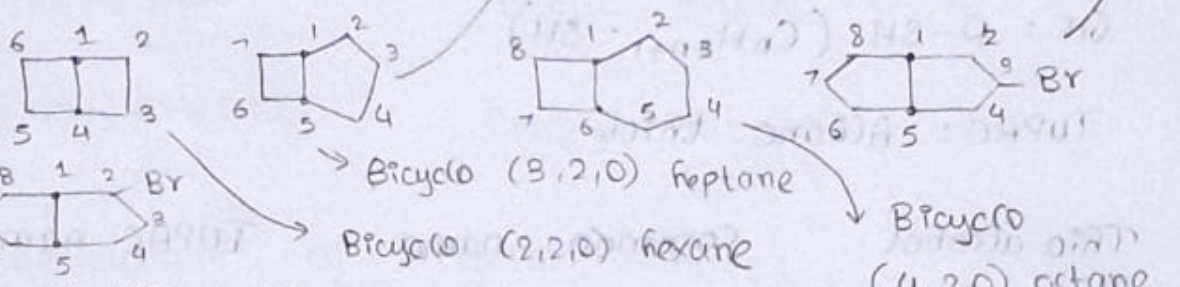
cyclo hexanone

Nomenclature of bicyclic compounds:

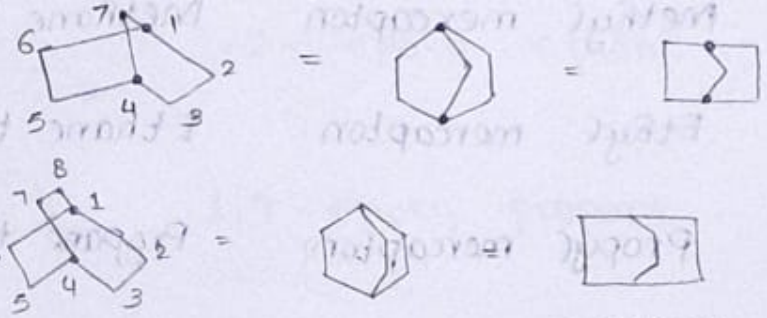
(i) Fused bicyclic

(ii) Bridged bicyclic

(iii) Spiro compounds



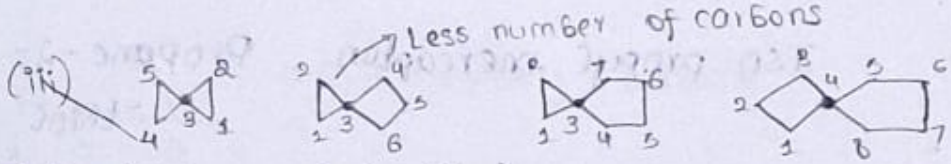
(ii) 2,7-dibromo bicyclo (3,3,0) octane



Bicyclo (2,2,1) heptane

Bicyclo (2,2,2) octane

(iii) Less number of carbons

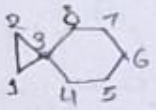


Spiro (2,2) pentane

Spiro (2,3) hexane

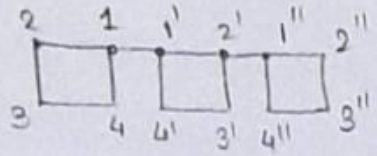
Spiro (2,4) heptane

Spiro (3,4) octane

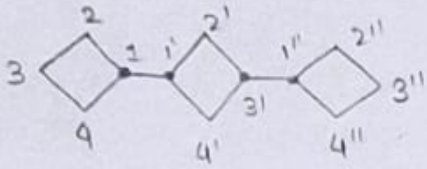


Spiro (2,5) octane

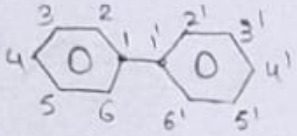
Nomenclature of identical cyclic units joined by single bonds:



1, 1', 2', 1'' - tri cyclo butane



1, 1', 3', 1'' - tri cyclo butane



1, 1' - biphenyl

Thioalcohol:

GF: R-SH ($C_nH_{2n+1}-SH$)

IUPAC: Alkane thiol

Thio alcohol	common name	IUPAC name
CH_3SH	Methyl mercapton	Methane thiol
CH_3CH_2SH	Ethyl mercapton	Ethane thiol
$CH_3CH_2CH_2SH$	Propyl mercapton	Propane thiol
$CH_3-\underset{CH_3}{\underset{\vert}{CH}}-SH$	Iso propyl mercapton	Propane-2-thiol

Nitro alkanes:

GF: $R-NO_2$ ($C_nH_{2n+1}-NO_2$)

IUPAC: Nitro alkane

Nitro alkane	Common name	IUPAC name
CH_3NO_2	Methyl nitrate	Nitro methane

$CH_3CH_2NO_2$ Ethyl nitrate Nitro ethane

$CH_3CH_2CH_2NO_2$ Propyl nitrate Nitro propane

Alkyl nitrite :

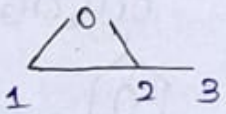
GF : R-ONO (C_nH_{2n+1}-ONO)

IUPAC : -

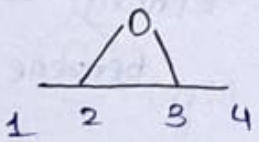
Alkyl nitrite	common name
CH_3ONO	Methyl nitrite
CH_3CH_2ONO	Ethyl nitrite
$CH_3CH_2CH_2ONO$	Propyl nitrite

Nomenclature of cyclic ethers:

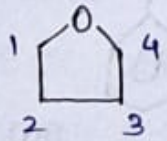
1,2 - epoxy ethane



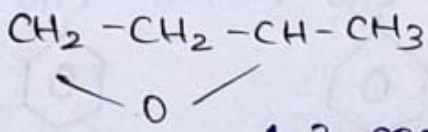
1,2 - epoxy propane



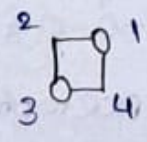
2,3 - epoxy butane



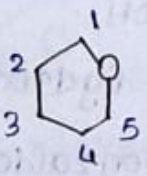
1,4 - epoxy butane



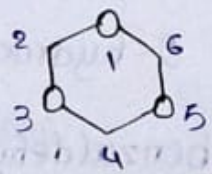
1,3 - epoxy butane



1,3 - dioxa cyclo butane



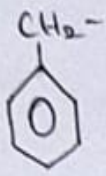
1,5 epoxy pentane



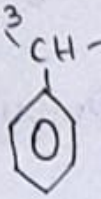
1,3,5 - trioxa cyclo hexane

Nomenclature of aromatic compounds:

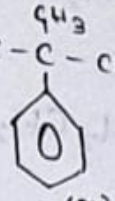
Methyl benzene (Toluene)



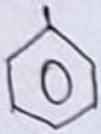
Ethyl benzene



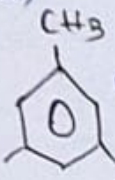
Iso propyl benzene / (Cumene)



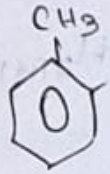
3° Butyl (or) benzene
$PhC(CH_3)_3$



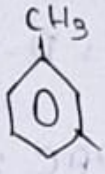
Vinyl benzene (Styrene)



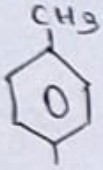
1,3,5- trimethyl benzene



(Ortho xylene)
1,2- dimethyl benzene



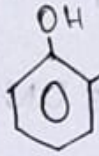
1,3- dimethyl benzene
(M- xylene)



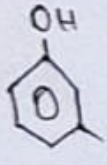
1,4- dimethyl benzene
P-xylene

(phenol)
(carbonic acid)

(Benzyl alcohol)
phenyl methanol

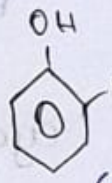


2-methyl phenol



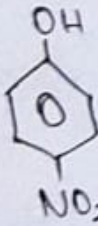
3- methyl phenol
(m-cresol)

4-methyl phenol
(p-cresol)

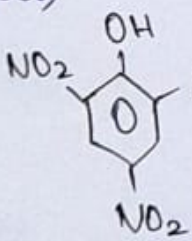


2-nitro phenol
(O- nitro phenol)

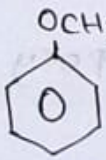
3-nitro phenol
(m-nitro phenol)



4- nitro phenol
(p-nitro phenol)

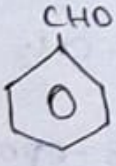


2,4,6- trinitro phenol
(picric acid)

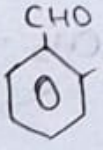


Methoxy benzene
(Anisole)

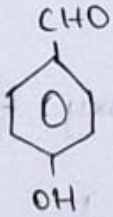
Ethoxy benzene
(phenetole)



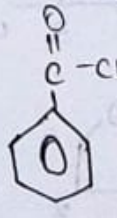
Benzaldehyde



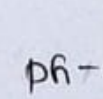
2- hydroxy benzaldehyde
(salicylaldehyde)



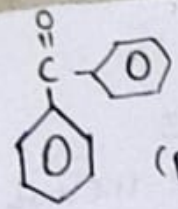
4- hydroxy benzaldehyde
(p- hydroxy benzaldehyde)



(or)

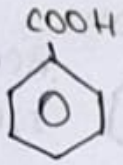


Acetophenone

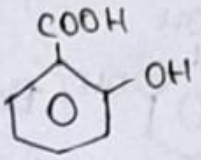


(Ph-C(=O)-Ph)

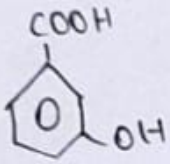
Benzophenone



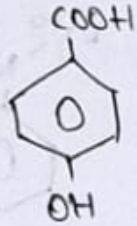
Benzoic acid



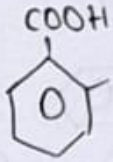
2-hydroxy benzoic acid (salicylic acid)



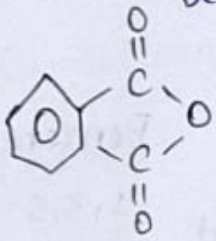
3-hydroxy benzoic acid (m-hydroxy benzoic acid)



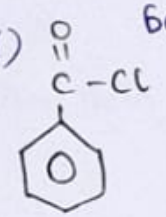
4-hydroxy benzoic acid



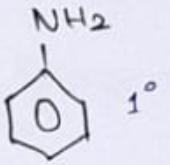
Benzene 1,2-dibaic (phthalic acid)



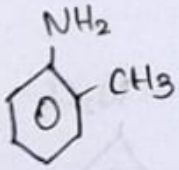
Phthalic anhydride



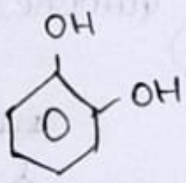
Benzoyl chloride



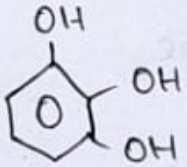
Aniline



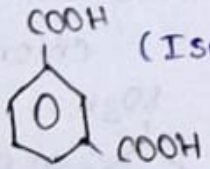
2-methyl aniline (o-toulidine)



Benzene 1,2-diol (Catechol)

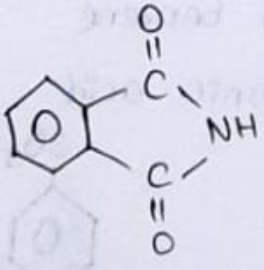


1,2,3-benzene triol (pyrogallol)

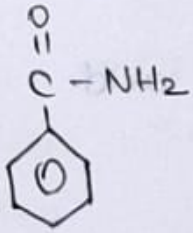


Benzene 1,3-dibaic acid

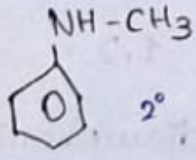
(Iso phthalic acid)



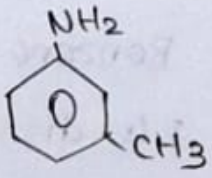
Phthalamide



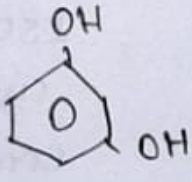
Benzamide



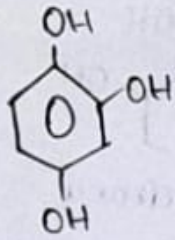
N-methyl aniline



3-methyl aniline (m-toulidine)

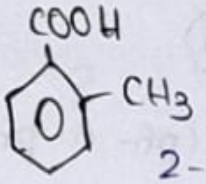


Benzene-1,3-diol (Resorcinol)

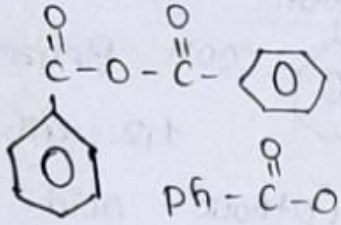


Benzene 1,2,4-triol (Hydroxy quinol)

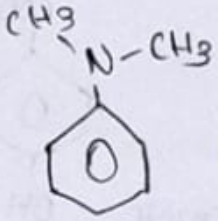
Benzene 1,4-dibaic acid. (Ter phthalic acid)



2-methyl benzoic acid

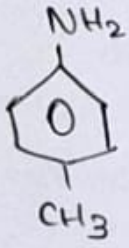


Benzoic anhydride $(phCO)_2O$



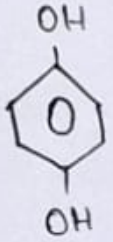
3°

N,N-dimethyl aniline



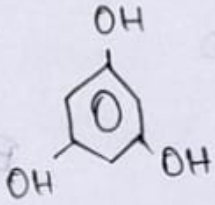
4-methyl aniline

P-toulidine



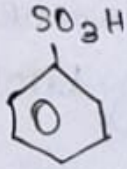
~~Ben~~ (hydro quinone)

(p-quinol)

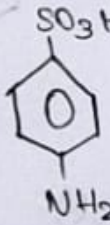


Benzene 1,3,5-triol

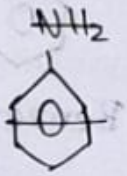
(~~chloro~~ phloroglu no



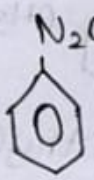
Benzene sulphonic acid



4-amino benzene sulphonic acid



(sulphanilic acid)

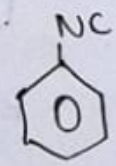


(or)

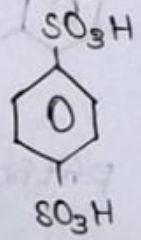
ph-N=N-Cl

Benzene diazoni chloride

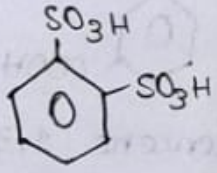
Cyano benzene (or) phenyl cyanide



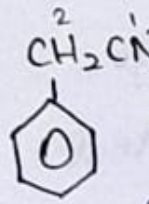
Iso cyano benzene (or) Phenyl carbyl amine



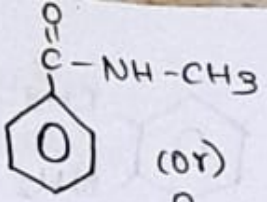
Benzene 1,4-di sulphonic acid



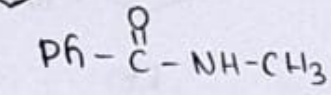
Benzene 1,2-disulphonic acid



2-phenyl ethane nitrile

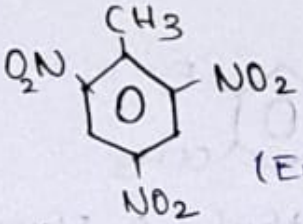


(or)



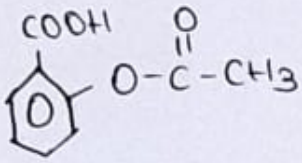
~~Acetamide~~

Acetanilide



(Explosive)

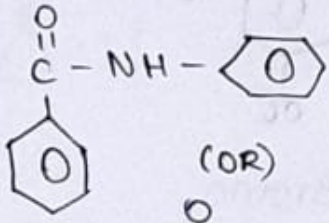
2,4,6 - Trinitro (TNT) toulene



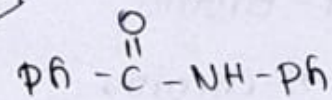
Acetyl salicylic acid

(2-acetoxy ~~salicylic~~ acid)

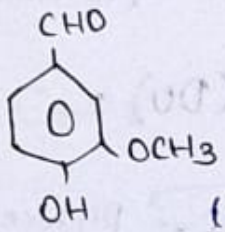
(Asprin)



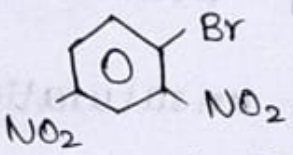
(OR)



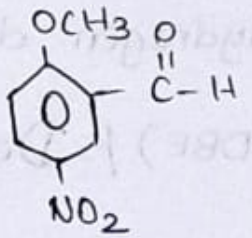
Benzanilide



(Vanillin)

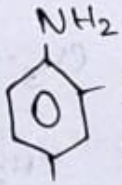


1-Bromo, 2,4-dinitro benzene

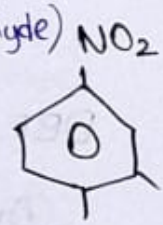


2-methoxy 5-nitro

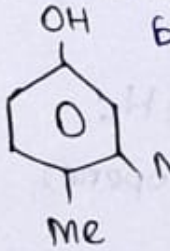
(4-hydroxy 3-methoxy benzaldehyde)



4-ethyl, 2-nitro aniline

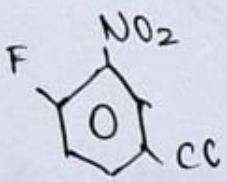


2-Bromo, 1-methyl, 4-nitro benzene

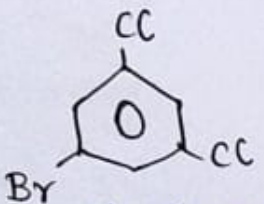


3,4 dimethyl phenol

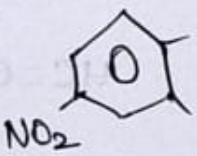
benzaldehyde



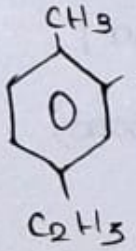
4-chloro, 1-fluoro 2-nitro benzene



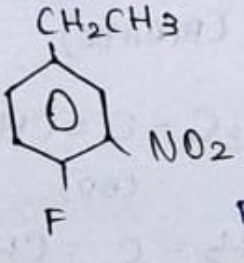
1-Bromo, 3,5-dichloro Benzene



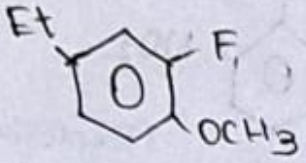
1-chloro, 2,4-dinitro benzene



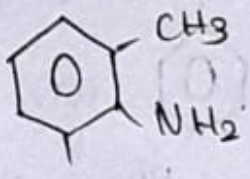
5-ethyl, 2-methyl aniline



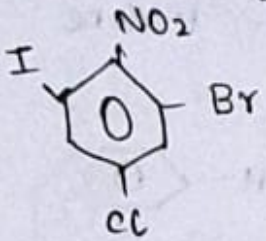
4-ethyl, 1-Fluoro, 2-nitro benzene



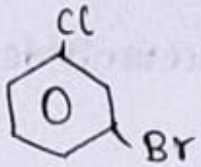
4-ethyl, 2-Fluoro, 1-methoxy benzene



2-ethyl, 6-methyl aniline



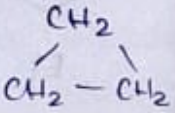
1-Bromo, 5-chloro, 3-iodo, 2-nitro benzene



1-Bromo, 3-chloro benzene

Hydrogen deficiency / Double bond equivalence (DBE) / Degree of unsaturation (DU):

* C_2H_4 (Ethene) — C_2H_6 (Alkane) — DBE = $2/2 \Rightarrow 1^\circ$ Difference in H atoms

* C_3H_6 (propene) — C_3H_8 (Alkane) — DBE = $2/2 \Rightarrow 1^\circ$ (One double bond / cyclic ring) — $CH_3-CH=CH_2$ (OR) 

* C_2H_2 (Ethyne) (Acetylene) — C_2H_6 (Alkane) — DBE = $4/2 \Rightarrow 2^\circ$ — $HC \equiv CH$

* C_3H_4 (propyne) — C_3H_8 (Alkane) — DBE = $4/2 \Rightarrow 2^\circ$ (one triple bond / 2 double bond)

$H_3C-C \equiv CH$

(OR)

$CH_2=C=CH_2$

* C_4H_6 C_4H_{10} DBE = 4/2 ⇒ 2°

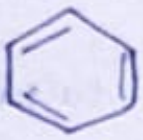
(Butyne) (Alkane)

$CH_3-CH_2-C\equiv CH$ / $CH_3-C\equiv C-CH_3$ /

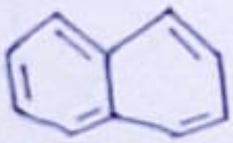
$CH_2=CH-CH=CH_2$ / $CH_2=C=CH-CH_3$ /

* C_6H_6 C_6H_{14} DBE = 8/2 ⇒ 4°

(Benzene) (Alkane)



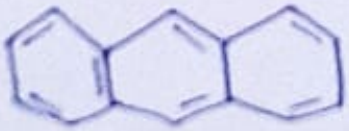
* $C_{10}H_8$ $C_{10}H_{22}$ DBE = $\frac{14}{2}$ ⇒ 7°



1 cyclic denotes 1 DBE

(Naphthalene)

* $C_{14}H_{10}$ $C_{14}H_{30}$ DBE = $\frac{20}{2}$ ⇒ 10°



(Anthracene)

* C_2H_3Cl (1X = 1H)

C_2H_4 C_2H_6 DBE = 2/2 = 1°

$CH_2=CH-Cl$

(Vinyl chloride)

★ C_3H_5Cl

C_3H_6 C_3H_8 DBE = 2/2 = 1°

$CH_2 = CH - CH_2 - Cl$

(Allyl chloride)

★ C_4H_4O (No effect of oxygen)

C_4H_4 C_4H_{10} DBE = 6/2 ⇒ 3°

(Furan)

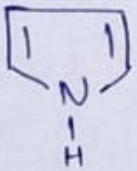
★ C_4H_4S (No effect of sulphur)

C_4H_4 C_4H_{10} DBE = 6/2 ⇒ 3°

(Thiophene)

★ C_4H_5N (1 N = −1 H)

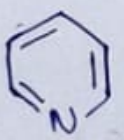
C_4H_4 C_4H_{10} DBE = 6/2 ⇒ 3°



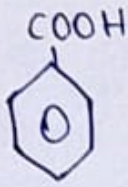
(Pyrole)

★ C_5H_5N

C_6H_4 C_5H_{12} DBE = 8/2 ⇒ 4°



(pyridine)



$C_7H_6O_2$

C_7H_{16}

DBE = 10/2

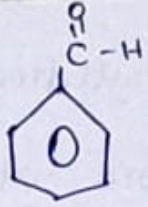
$\Rightarrow 5^\circ$

C_7H_4

C_7H_{16}

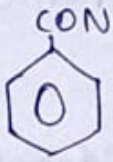
DBE = 12/2

$\Rightarrow 6^\circ$



DBE = 5°

DBE = 5°



DBE = 5°

(Phenol)

DBE = 4°

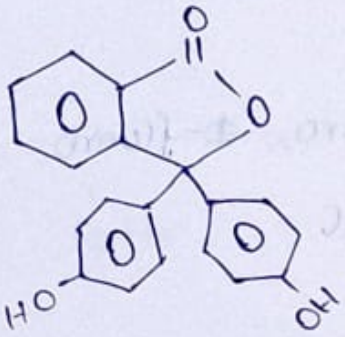
ph − N ≡ N − ph

(Azo benzene)

DBE = 9

phN_2Cl / ph − N = N − Cl

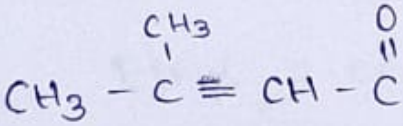
DBE = 5



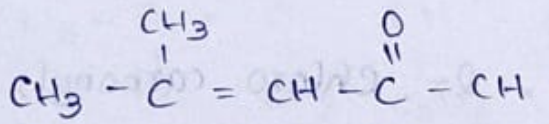
(phenolphthalein)

DBE = 14°

4-methyl pent 3-ene 2-one



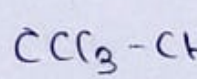
(Mesityl oxide)



(phorone)

2,6-dimethyl

hept-2,5 diene, 4-one

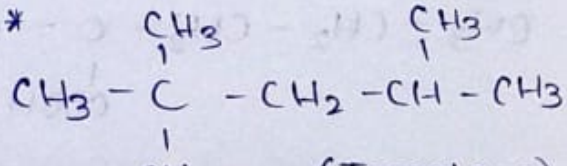


(Chloral)

2,2,2-trichloro

ethanal

*

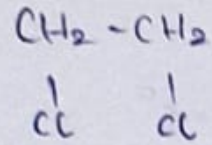


(Isooctane)

2,2,4-trimethyl pentane

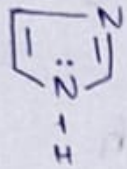
CH_3CHCl_2 (ethylidine chloride)

1,1 - dichloro ethane

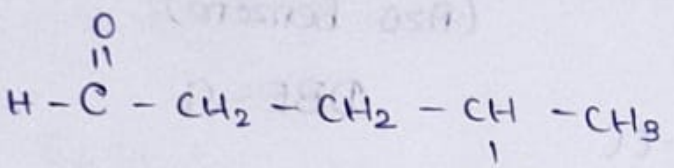


ethylene chloride

1,2 - dichloro ethane

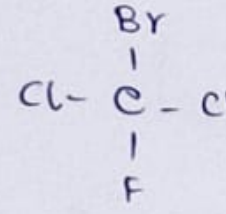


→ Imidazole

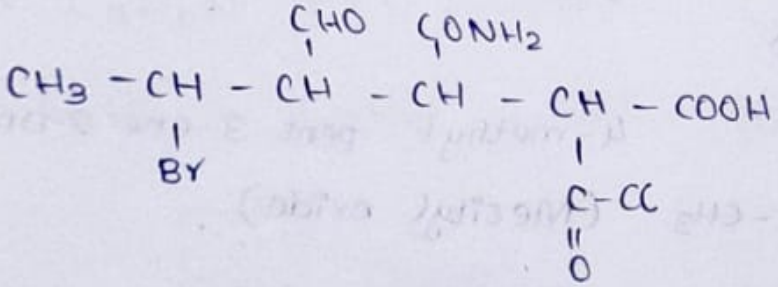


2- methyl pentan-1,5 dial

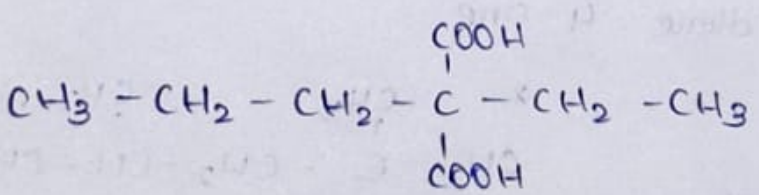
CCl_4 1,1,1,1 - tetra chloro methane



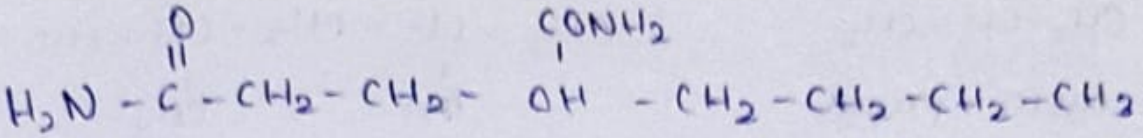
2- Bromo, 2-chloro, 2-fluoro ethanal



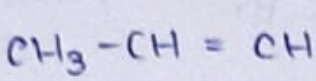
5 - Bromo, 3- carbamoyl, 2- chloro carbonyl, 4- formyl hexanoic acid



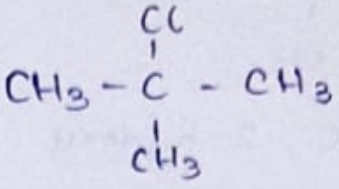
2- ethyl, 2-propyl propan-1,3-dioic acid



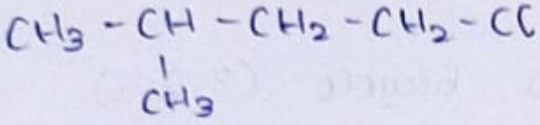
2- butyl , pent 1-5 diamide



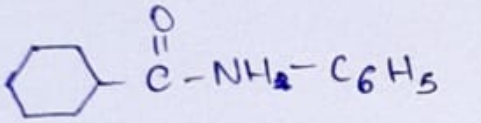
2- butenal



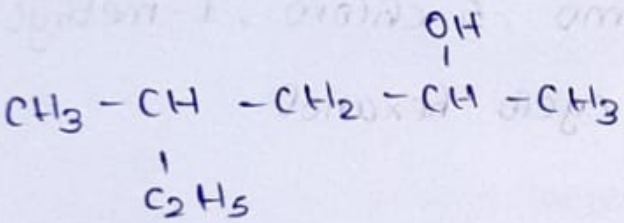
2-chloro , 2-methyl propane



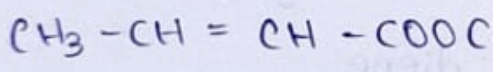
1-chloro , 3- methyl butane



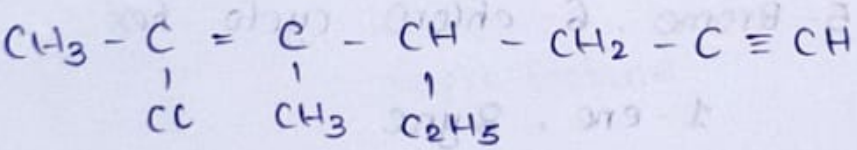
n-phenyl cyclo hexane carboxamide



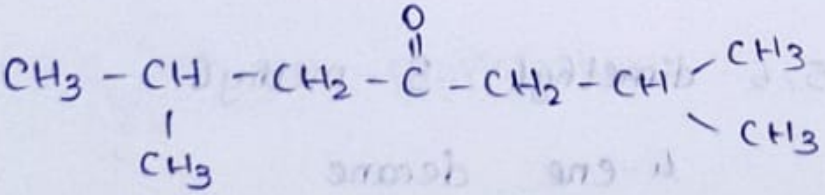
4-methyl 2- hexanol



Ethyl , 2-ene butanoate



6-chloro 4-ethyl 5- methyl 5- heptene 1-yne



2,6 dimethyl ~~pent~~ heptane 4-one

$CH_2-CH=CH_2$

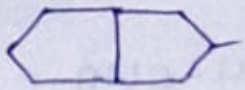
3-cyclo propyl prop-1-ene

$CH_3-CH(OH)-CH_2-CH(CH_3)-CHO$

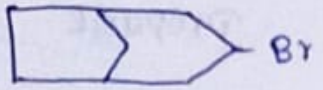
4-hydroxy, 2-methyl pentanal

$CH_2(NH_2)-CH(OH)-COOH$

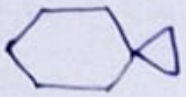
3-amino, 2-hydroxy Propanoic acid



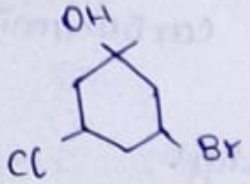
3-Bromo bicyclo (3,3,0) octane



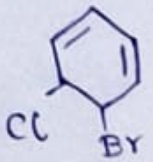
3-Bromo bicyclo (3,2,1) octane



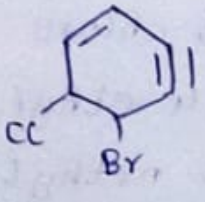
Spiro (2,5) octane



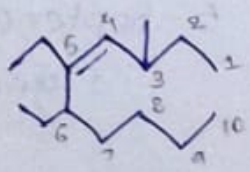
3-Bromo, 5-chloro, 1-methyl cyclo hexanol



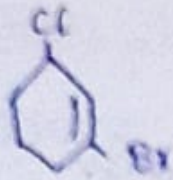
5-Bromo, 6-chloro cyclo hex 1,3-diene



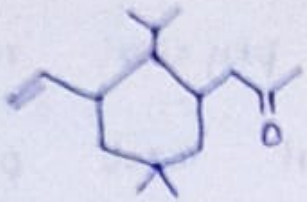
5-Bromo, 6-chloro cyclo hex 1-ene, 3-yne



5,6-dimethyl 3-methyl 4-ene decane

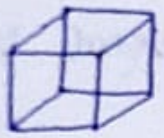


1 - Bromo, 3 - chloro cyclo hexene



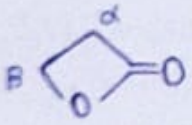
$$Z = 3 \times \frac{\text{No of } \sigma \text{ bonds}}{\text{DBE}_3} \times \frac{3^\circ \text{ carbon atoms}}{\text{No. of } \pi \text{ bonds}_2}$$

$Z = 90$

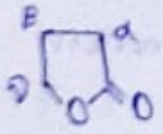


DBE of cubane

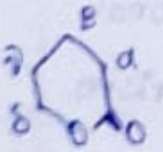
C_8H_8 C_8H_{18} $DBE = \frac{10}{2} = 5$



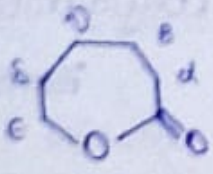
β - propiolactone



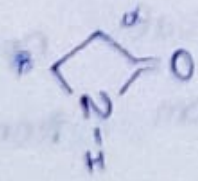
γ - butyro lactone



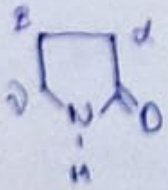
δ - valero lactone



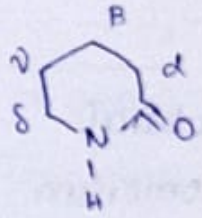
ϵ - capro lactone



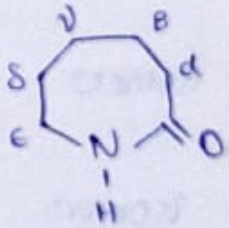
β - propiolactum



γ - butyrolactum



δ - valero lactum



ϵ - capro lactum